

"Would You Be Willing to Wait?": Consumer Preference for Green Last Mile Home Delivery

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Summary: This research considers whether Mexican consumer preferences for last mile home delivery options can be influenced by environmental incentives, which include CO₂ equivalent, electricity, trash, and trees. The results suggest that consumers are willing to wait longer for their home deliveries when given the resulting environmental impact reduction. Assuming longer delivery lead times, we provide an alternative methodology to lower fuel consumption and reduce carbon emissions in last mile deliveries of a one-warehouse-N-customer system.



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KEY INSIGHTS

1. Providing environmental impact information increases consumer willingness to wait by 20% and consumer tolerance by 0.5 days on average.
2. Information on trees saved is the most effective at incentivizing consumers to wait longer, regardless of education, occupation or socioeconomic status.
3. Using extended delivery lead time, vehicles can improve utilization, resulting in lower fuel consumption and reduced carbon emissions.

Introduction

Companies provide various home delivery options (one-day, three-five-day, two-week) to consumers. Shorter delivery times, while convenient for the consumer, present logistical difficulties for companies, both in planning deliveries and managing their fleets. Extending delivery times provides opportunities to

improve truck utilization and reduce a company's carbon footprint, but how can a company convince its customers to wait longer for their deliveries?

In this research, we study environmental incentives to drive consumer behavior. Our research focuses on whether consumers are willing to wait longer for their deliveries when given the resulting environmental impact information of shorter delivery times. Our corporate partner, Coppel, operates approximately 1,300 retail stores across ten regions of Mexico, specializing in household goods and clothing. The Company, as well as many other Consumer Packaged Goods (CPG) and retail companies that provide home delivery, are looking for additional delivery options that tap into consumers' demand for sustainable delivery options. Currently, the Company provides one-day delivery to all of its customers; however, this offering reduces the Company's transportation efficiency: more trucks are sent out underutilized, increasing the

number of trips and vehicles on the road. As a result, carbon emissions per customer per product increase.

In order to evaluate consumer preference, we establish the following hypotheses:

1. The following groups prefer green delivery options over other groups:
 - a. Age: Millennials (aged 25-34) over other generations
 - b. Education: Highly educated (University or higher) population over the rest of the population
 - c. Socioeconomic Status: High income and status population over the rest of the population
 - d. Region: Urban population (Mexico City) over suburban population
2. Providing environmental impact information increases consumer preference towards a green delivery option
3. Different types of environmental impact information results in different consumer preferences toward a green delivery option. We test four equivalent expressions for 10 tons of CO₂ emissions, calculated using the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator:
 - a. CO₂ equivalent: 10 tons of CO₂ emissions
 - b. Electricity: 1 Homes' electricity use for 2 months
 - c. Trash: 500kg of waste recycled instead of landfilled
 - d. Trees: 45 tree seedlings grown for 10 years

Methodology

We conduct a field study of approximately one thousand Mexican households in ten regions across Mexico (see Figure 1). The two factors that we test for are 1) willingness to wait and 2) number of additional days willing to wait. We cross-tabulate the data to discern relationships between an attribute, such as age, gender, education, socioeconomic status,

occupation, and willingness to wait. We also profile the respondents according to age, education, occupation, socioeconomic status, and region. In particular, for socioeconomic status, we group the households according to data from the National Institute of Statistics, Geography and Informatics (INEGI).



Figure 1. Regions in scope of field study

Willingness to Wait – Statistical Analysis

To assess the statistical significance of our findings, we conduct several tests. First, we compare willingness to wait (yes/no) using the Difference of Means test (one-sample t-test). Next, using the Difference of Means test (two-sample t-test), we compare the effects of three levels (treatments) – no incentives, economic incentives, and environmental incentives – willingness to wait, and then run the same analysis on the number of additional days willing to wait.

Next, using the Chi-Square Goodness-of-Fit test, we determine if the proportion of items in each attribute is significantly different from the proportions of the rest of the same attribute. For example, we determine whether the proportion of 25-34 year olds willing to wait (observed frequency) is the same as the proportion of all other ages willing to wait (expected frequency).

To add robustness to the analysis, we complement the Chi-Square Goodness-of-Fit Test with one-way Analysis of Variance (ANOVA) to determine whether the means of various levels in an attribute are equal. For example, we determine whether the mean willingness to wait (willing to wait = 1, not willing to wait = 0) of 25-34 year olds is different from the mean willingness to wait of all other ages. For those levels whose means are not equal, we conduct a Tukey Honestly Significant Difference (HSD) test to determine the size of the difference and resulting confidence intervals.

Finally, we run a binary logistic regression analysis on willingness to wait with predictor variables age group, education level, socioeconomic level, occupation, and region. While the Goodness-of-Fit analysis uses categorical variables for all demographic groups, the regression uses normalized values for age, education level, and socioeconomic level, allowing us to evaluate each group as a continuous variable.

Results of Analysis

Field Study Results

Our primary finding is that providing environmental impact information incentivizes customers to wait longer by 20% on average. Furthermore, regarding the specific type of environmental incentives (CO₂ equivalent, electricity, trash, trees), information on number of trees saved has the greatest impact on a customer's willingness to wait (over 75%, see Figure 2). We also show that education, occupation, and socioeconomic status have little impact on willingness to wait and the number of additional days willing to wait. Regarding age, although we cannot not conclude that millennials are more willing to wait when given environmental incentives, a binary logistic regression analysis shows that a respondent's willingness to wait

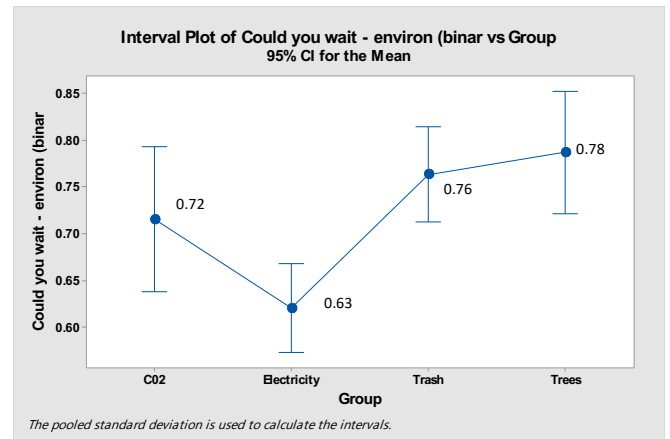


Figure 2. Willingness to wait based on environmental impact information

increases with decreasing age. For example, millennials are more likely to be willing to wait than are baby boomers (aged 55-64). The findings suggests that a respondent's age should be further studied to determine the correlation between age and willingness to wait. Region does have a significant impact, however, as evidenced by responses in regions of Mexico City (Atzapalsalco and Iztapala), which show less willingness to wait than those responses in other less urban regions.

Carbon Emissions Savings

Based on the field study data and industry comparisons, we find that customers can tolerate a four-day delivery time on average (see Figure 3).

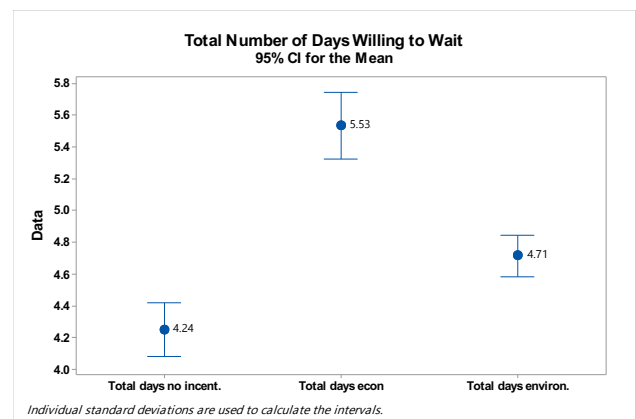


Figure 3. Number of days willing to wait

Using a four-day delivery window, we provide a high level estimate of the environmental impact of “green delivery” (four-day delivery) for the Company in the sample region (Culiacan, Mexico). To determine the level of utilization, we tested three major constraints on utilization: weight, number of stops (time) and distance. Based on delivery data collected over a seven month period, representing approximately 1,250 tons of cargo delivered, and 27,928 delivery stops, the results of our analysis suggest that the number of stops (time) is the most restrictive constraint for the Company’s home delivery trucks in Culiacan. We estimate that the trucks can increase their number of stops from 13 to 16 and subsequently increase their utilization from 49% currently to 57%. As a result, the total number of trips is reduced by 298 over a period of seven months.

To calculate the environmental impact, we use the Network for Transport and the Environment methodology, measured as emissions to air (kg of CO₂), as follows:

$$Em_{i,x,y}^{Tot} = EF_{i,x,y} * FC_{x,y_x} * Dist$$

The equation calculates the total emissions *Em* of a substance *i* (CO₂) for driving on road *x* (Culiacan) with vehicle *y* (Nissan NP300). *EF* represents the emissions factor. *FC* represents the fuel consumption, and *Dist* represents the distance traveled. Using 16 stops as our constraint, the estimated carbon emission savings of changing from one-day delivery to four-day delivery is 10,631 kg of CO₂ over a time period of seven months in Culiacan, Mexico (1,518 kg CO₂ per month). Total fuel savings is 5,361 liters diesel and 31,621 km in distance.

Conclusion

Based on our analysis, we recommend that the Company implement green delivery, providing environmental impact information to incentivize consumers.

Consumers show a willingness to wait (four days on average) when provided the resulting environmental impact of shorter delivery times. Given longer delivery lead times, companies can improve vehicle utilization and, consequently, reduce fuel consumption and carbon emissions. To further study the level of consumer demand for green delivery and interest in sustainable products, a U.S.-based field study could be conducted to assess differences in consumer preferences between U.S. and Mexican consumers. Knowing the appropriate consumer group would allow the Company to target its marketing campaigns to maximize adoption and minimize carbon emissions. Finally, a pilot study in one store of one region could be conducted to test the results of the findings.